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ABSTRACT

The two conference papers comprising this document address course development and assessment procedures used in distance education at the West German Open University. The first paper, on course design and development techniques used in distance teaching, reviews some of the techniques of course evaluation and course design that have been used in the Open University and emphasizes the importance of the relationship between the two. It starts by discussing methods used in the Open University's Science Foundation Course to strengthen this relationship, and concludes with a specific example of how a particular design prescription might be modified in the light of information collected. The second paper, on assessment procedures used in distance teaching, reviews some of the procedures that have proved to be of value in developing assessment material, primarily for grading purposes. The paper begins by stressing the need to identify the purpose behind any form of assessment used, and discusses the type of anomalies that can arise if this is not done. It then addresses the role that item analysis and behavioral objectives play in the development of assessment material. Each paper includes references. (GL)

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ZIFF PAPIERE Nr. 12

REGINALD F. MELTON

- COURSE DESIGN AND DEVELOPMENT TECHNIQUES USED IN DISTANCE TEACHING
- ASSESSMENT PROCEDURES USED IN DISTANCE TEACHING

Zentrales Institut für Fernstudienforschung

FEBRUAR 1977

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REGINALD F. MELTON

COURSE DESIGN AND DEVELOPMENT
TECHNIQUES USED IN DISTANCE TEACHING

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COURSE DESIGN AND DEVELOPMENT TECHNIQUES USED IN DISTANCE TEACHING

A paper presented to the Fachbereich Erziehungswissenschaften, Fernuniversität, Germany, on 17th December 1976.

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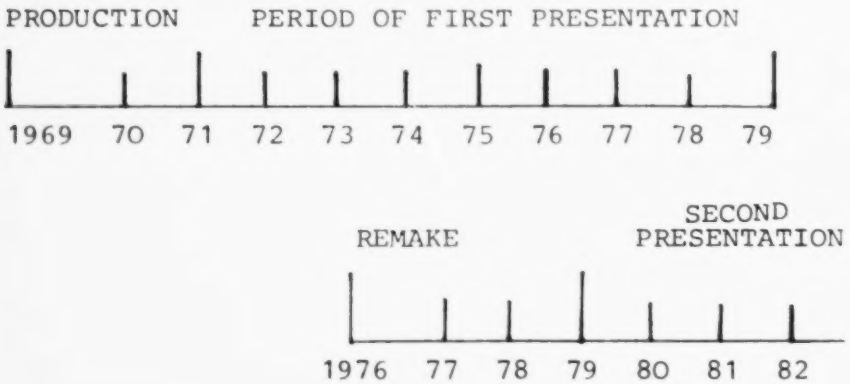
1 INTRODUCTION

This paper reviews some of the techniques of course evaluation and course design that have been used in the Open University, and emphasises the importance of the relationship between the two. It starts by looking at methods used in the Open University's Science Foundation Course to strengthen this relationship, and concludes with a specific example of how a particular design prescription might be modified in the light of information collected.

2 COURSE EVALUATION AND RELATED DECISION MAKING

To understand the methods used on the Science Foundation Course we must first take a brief look at the development cycle for that course. It was produced over a period of two years by a team consisting of 15 subject specialists, 2 editors, a number of BBC producers, an educational technologist and several consultants. Work began in 1969, and the course was presented to the student population in 1971 after going through a number of drafts. The course is currently being remade, and the new course will be presented to students in 1979.

Diagram 1. Course Development Cycle of Science Foundation Course



Evaluation of the course began long before it was first presented to students, and has continued to the present date. The techniques used are described in some detail in "Course Evaluation at the Open University, A Case Study[1]", and are summarised in the table below.

Table 1. Course Evaluation Techniques On The Science Foundation Course

Feedback \ Period	Production	Presentation
Course Team	C.T. Discussions Papers	
Students	Interviews Developmental Testing	Interviews Surveys Curf CMA Feedback Student Letters Item Analysis
Regional Staff	C.T. Discussions	Surveys (CT4) Tutor Notes (TMAs) Counsellor Notes (CMAs)
Research Groups	Reports Aids to Design and Decision Making	Reports Aids to Design and Decision Making

By 1975 so much information had been gathered on the course that it had become clear that the main problem was not how to evaluate the course, but how to ensure that all the information collected was effectively used. Emphasising this need was the knowledge that the most substantial modifications to the course had been made as it went through successive drafts in the early stages of

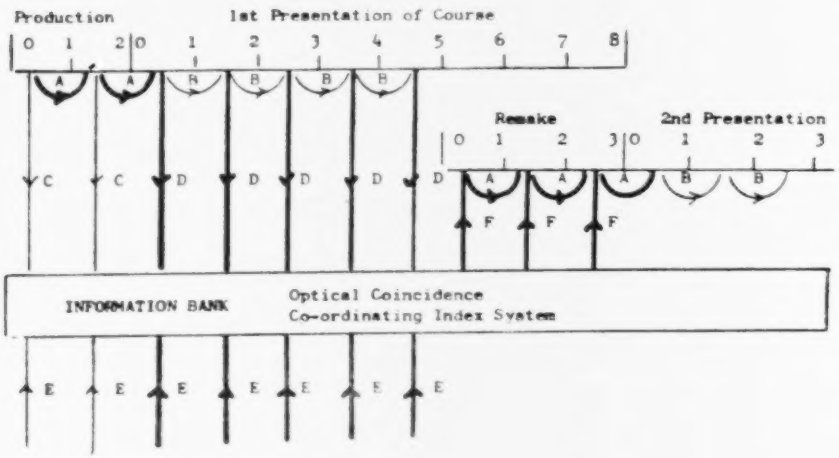
production, at a time when the feedback information available was both limited, and subjective, in nature. Once the course, with all its interrelated components, had been presented to students, economic considerations alone limited the modifications that were possible. The situation was therefore somewhat anomalous in that the quantity, and quality, of information available to inform decision making had increased considerably, but the opportunities for modifying the course were much more limited than during the period of course production.

The solution envisaged was to focus attention on the remake of the course when major changes would be possible. The idea was to identify, as far as possible, questions of principle that would be discussed during the early phases of the remake, and to make sure that all possible information was made available to course team members in order to ensure that decisions werde made on the most informed basis possible. With so much information available an information bank, and a rapid retrieval system, was seen as essential.

The Bank was set up during 1976 and contains a wide variety of information not only on the course itself but also from a number of other relevant sources both inside and outside the university. The information gathered varies in nature from discussion papers to highly objective statistical reports. The main intent of those developing the bank is to ensure that, when specific questions are debated during the early phases of the remake of the course, that relevant information will be available in a readily digested form to help inform decision making.

Information is thus brought to bear at a time when change is most likely to occur. The process envisaged is summarised in diagram 2.

Diagram 2. System of ensuring informed decision making with help of information bank.


Production
1st Presentation of Course
0 1 2 0 1 2 3 4 5 6 7 8
A A B B B B
C C D D D D D
Remake
2nd Presentation
0 1 2 3 0 1 2 3
A A A B B
F F F
INFORMATION BANK
Optical Coincidence
Co-ordinating Index System
E E E E E E E

Key

Magnitude of modifications possible in original course, and its remake:	large small	
Nature of information collected directly from course for storage in information bank:	limited, subjective considerable, much being objective	C D
Relevant information collected from sources other than course for storage in information bank:	considerable, both objective and subjective	E
Information brought to bear on decision making processes in remake of course:	considerable, but presented in digestible form	F

The philosophy involved is an extremely simple one. Design techniques are most likely to be improved if course teams are made aware of the deficiencies of existing techniques at a time when change is actually possible. Evaluation is thus seen as a means of creating an awareness of a need. Nor should the work of development cease at this point. Evaluative information may be seen as threatening or unhelpful if presented alone, and it is important that it should be

supported by positive prescriptions for improvement.

3 Prescriptions for Course Design

In behavioural objectives we have an interesting example not only of a tool used in course design, but also of how prescriptions for course design might be improved in the light of information collected from a variety of sources.

Behavioural objectives have been used in a variety of forms in Open University courses, and the Science Foundation Course provides us with an interesting example with behavioural objectives stated in detail at the beginning of each Unit. But we might ask whether student learning might be more enhanced if behavioural objectives are placed at the end of each Unit, or spread throughout each Unit so that each objective is close to the related content. Research on behavioural objectives concerning this question is very limited, but considerable insights can be gained by looking at related research concerning the use of questions inserted into texts.

A number of such studies are reviewed in the paper entitled "Resolution of Conflicting Claims Concerning Behavioural Objectives[(2)]". The studies reviewed were concerned with the effect on student learning of inserting questions into texts either immediately before, or immediately after, the passages to which they referred. The question-related passages were described as relevant information and the questions as pre-, or post-, questions according to their location.

In reading the instructional material containing either pre-, or post-, questions, students were not permitted to review any section of the text once it had been read. On completion they were tested to determine not only their acquired knowledge of relevant information, but also that of incidental information (that is textual information not related to the inserted questions).

A number of findings emerged from the studies. First, relevant learning was enhanced by the provision of inserted questions, with post-questions more effective than pre-questions in this respect. Second, incidental learning was enhanced by the provision of post-questions, but not by pre-questions which in some cases depressed incidental learning. Finally, it was oberserved that the above effects were more likely to be observed when questions were inserted one at a time into the text (before, or after, every 10 sentences for example) than when the same number of questions were inserted into the text in groups (for example, 5 questions at a time before, or after, every 50 sentences).

From the studies it would appear that the same questions function in different ways according to their location in the text. Placed immediately before related passages they appear to function as orienting stimuli directing student attention to the relevant and away from the incidental. The effect is to enhance relevant learning but to depress incidental learning. Questions inserted immediately after related passages, however, appear to function as reinforcement stimuli, stimulating further consideration of the relevant without depressing incidental learning that has

already taken place. The fact that post-questions can enhance not only relevant learning but also incidental learning suggests that when this occurs the two types of information are related.

Since behavioural objectives should clearly indicate what a student should be able to do as a result of the learning process, and how what he does should be measured, one might expect behavioural objectives to function in much the same way as inserted questions, producing orienting, or reinforcement, stimuli according to their location in the text, or according to the way in which they are used. With the research on inserted questions in mind it would appear logical to recommend that in future behavioural objectives should not be placed together at the beginning or end of each Unit, but should be inserted separately at frequent intervals into the text immediately after each related passage. Such objectives would be more likely to function as reinforcement stimuli than objectives placed immediately before each related passage. One might hypothesise that such post-objectives should enhance relevant learning more than pre-objectives, and should be less likely to depress incidental learning.

Needless to say behavioural objectives are used for a variety of purposes, and it is clear that the above discussion is limited to the use of behavioural objectives to enhance student learning. Other uses of behavioural objectives are discussed in the related paper on "Assessment Procedures Used in Distance Teaching(3)".

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A Case Study Paper presented to the Congress of the European Association for Research and Development in Higher Education in Louvain, Belgium on 1st September 1976
To be published in the British Journal of Educational Technology in 1977.

2 Melton, R. F. Resolution of Conflicting Claims Concerning Behavioural Objectives
Paper to be presented to the American Educational Research Association's Annual Conference to be held in New York in April, 1977.

3 Melton, R. F. Assessment Procedures Used in Distance Teaching
ZIFF Papiere 12, S. 14 f.
Hagen, Germany: Fernuniversität, 1976.

ASSESSMENT PROCEDURES USED IN DISTANCE TEACHING

A paper presented to the Zentrales Institut für Fernstudienforschung, Fernuniversität, Germany on 17th December 1976.

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1 Introduction

This paper is a review of some of the procedures that have proved to be of value in developing assessment material, primarily for grading purposes, at the Open University. The paper begins by stressing the need to identify the purpose behind any form of assessment used, and discusses the type of anomalies that can arise if this is not done. It then goes on to look at the part which item analysis and behavioural objectives may play in the development of assessment material.

2 Purposes of Assessment

Assessment material might be developed for a variety of reasons, and it is important to keep the relevant purpose of any assessment clearly in mind. For example, it may be used

To grade students
To measure student mastery of objectives
To aid student learning.

Any confusion of purpose may lead to particular problems. For example, one cannot expect tests designed to measure student mastery of objectives to be appropriate for grading purpose, for if the majority of students master the majority of test items the test will not be an accurate means of placing students in rank order.

In the past assessment material at the Open University has been designed with particular standards (mastery) in mind, but at the same time it has been used for grading purposes. This gives rise to anomalies particularly where scores are to be added. The following simple

examples should illustrate the point.

Table 1 indicates hypothetical raw scores for a group of 5 students on two separate tests, one concerned with biology and one with physics. Since the students are to be ranked in order of ability in science the two scores, which place students in opposite rank order, are to be added together. If the raw scores are added together, as in table 1, it will be noted that the final overall order is determined by the biology test, that is the test with the largest standard deviation of scores.

Table 1

Test / Student	Biology	Physics	Total
A	70 (1)	18 (5)	88 (1)
B	60 (2)	27 (4)	87 (2)
C	50 (3)	36 (3)	86 (3)
D	40 (4)	45 (2)	85 (4)
E	30 (5)	54 (1)	84 (5)
Mean (M)	50	36	
Standard (s) Deviation	$\sqrt{200}$	$\sqrt{162}$	

Addition of Raw Scores (X) with different means and different standard deviations.

If the physics scores in table 1 are multiplied by 10/9 the standard deviations for both test scores will be the same, and the two tests will contribute equally to the final rank order (table 2).

Table 2

Student \ Test	Biology	Physics	Total
A	70 (1)	20 (5)	90 (1=)
B	60 (2)	30 (4)	90 (1=)
C	50 (3)	40 (3)	90 (1=)
D	40 (4)	50 (2)	90 (1=)
E	30 (5)	60 (1)	90 (1=)
Mean (M)	50	40	
Standard (s) Deviation	$\sqrt{200}$	$\sqrt{200}$	

Addition of Adjusted Scores with different means but same standard deviations.

Altering the mean scores has no effect on the overall rank order as can be seen from table 3. However, for purposes of comparing performances on tests it is useful to adjust tests to have the same mean as well as the same standard deviation.

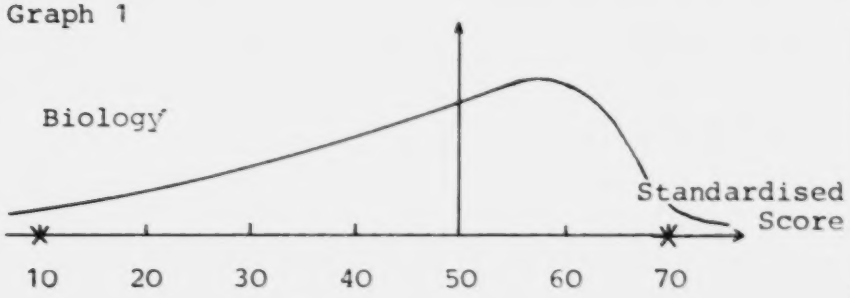
Table 3

Student \ Test	Biology	Physics	Total
A	70 (1)	30 (5)	100 (1=)
B	60 (2)	40 (4)	100 (1=)
C	50 (3)	50 (3)	100 (1=)
D	40 (4)	60 (2)	100 (1=)
E	30 (5)	70 (1)	100 (1=)
Mean (M)	50	50	
Standard (s) Deviation	$\sqrt{200}$	$\sqrt{200}$	

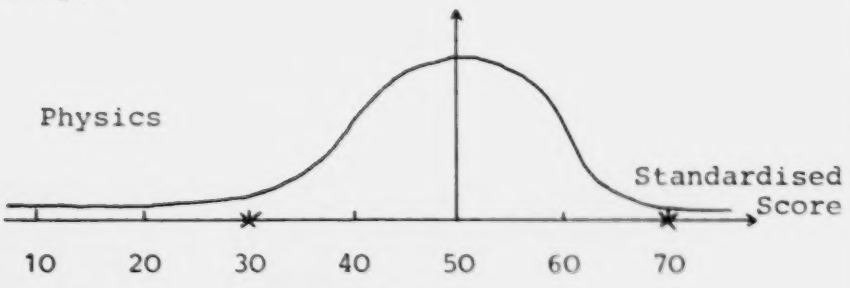
Addition of Standard Scores with same means and same standard deviations.

The standardisation of scores is not sufficient in itself to remove all grading anomalies when scores are added, for standardisation alters the means and standard deviations but not the shape of the distribution concerned. Thus we might have two students, A and B, with what appears to be roughly comparable performances on the two tests. Student A is the top of the class in physics but the bottom in biology. Student B is the bottom in physics but the top in biology (Graphs 1 and 2). Because of the skewness of the biology scores student B is ranked top on the combined scores. If the test scores are normalised this anomaly will disappear.

Graph 1



Graph 2



If scores are not normalised prior to addition for grading purposes course teams need to answer a number of difficult questions. A few of these are raised with reference to data (table 4)

collected from 16 computer marked assignments presented to students on the Science Foundation Course in 1974.

Table 4. Data Taken From Computer Marked Assignments Presented to Students on Science Foundation Course in 1974.

Index \ Assignment	41	42	43	44	45	46	47	48
Mean Score	85.2	77.3	78.0	78.0	77.4	66.6	64.2	72.5
Standard Deviation	13.0	13.2	15.0	13.2	14.6	16.0	15.7	19.1

Index \ Assignment	49	50	51	52	53	54	55	56
Mean Score	80.9	71.6	68.4	62.2	51.5	81.2	82.9	55.6
Standard Deviation	13.0	12.0	14.2	11.0	9.2	11.0	11.6	9.7

The following are two such questions which course teams would need to answer satisfactorily if they were to object to the assignment scores being normalised prior to addition for grading purposes.

> Should assignment 48 contribute more to a student's overall score than assignment 53? The differences in standard deviations will certainly have this effect in determining a student's overall ranking.

If a student achieves a score of 85.2 on assignment 41 but only 51.5 on assignment 53 does it follow that his level of performance has fallen badly? Does the difference in mean scores indicate differing student abilities in the two areas or different standards of test design?

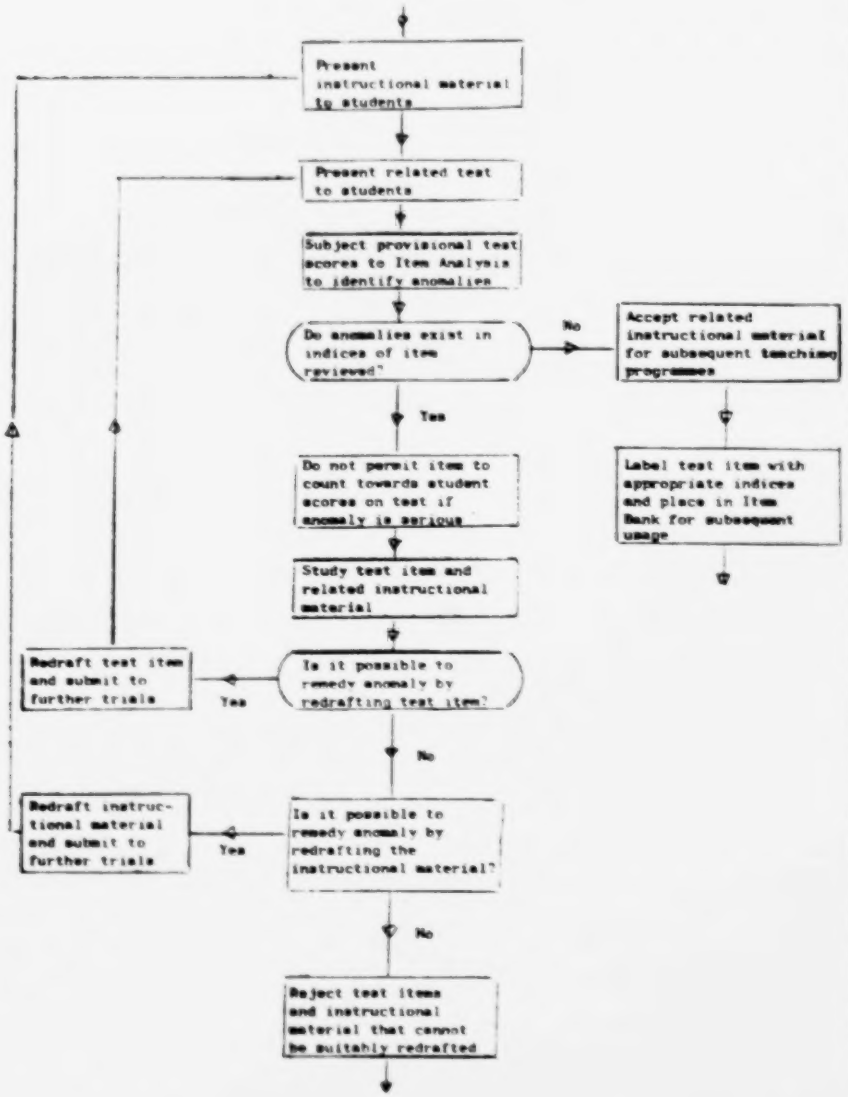
3 Item Analysis

Where tests have been designed primarily to grade students test items and tests may be improved with the help of item analysis. Such a facility is used in the Open University providing a range of statistics on both individual items and tests as a whole. The nature of the statistics used are fully described in "Item Analysis at the Open University: A Case Study[1]". Two statistics might be picked out for further comment. The Discrimination Index is particularly important since it tells us to what extent each item helps to rank students on the test as a whole, or in other words to what extent each item discriminates between students. The Coefficient of Internal Consistency is a further statistic of particular value which provides us with an indication of the reliability of the test as a whole and hence with a measure of the error associated with any score awarded on the test. The reliability of a test may normally be increased by increasing the number of items with good discrimination in the test.

Item analysis has two distinct roles to play

in student assessment. In the first instance, it may be used to help identify gross anomalies in items, enabling such items to be removed from a test before scores are actually awarded to students. In the second instance it may be used to build up banks of items with known characteristics. Such items may be used to produce reliable tests for future use. The Procedures envisaged are summarised in diagram 1.

Diagram 1. Method of Using Item Analysis Data.


Present instructional material to students
Present related test to students
Subject provisional test scores to Item Analysis to identify anomalies
Do anomalies exist in indices of item reviewed?
No
Accept related instructional material for subsequent teaching programmes
Yes
Do not permit item to count towards student scores on test if anomaly is serious
Label test item with appropriate indices and place in Item Bank for subsequent usage
Study test item and related instructional material
Redraft test item and submit to further trials
Is it possible to remedy anomaly by redrafting test item?
Yes
No
Redraft instructional material and submit to further trials
Is it possible to remedy anomaly by redrafting the instructional material?
Yes
No
Reject test items and instructional material that cannot be suitably redrafted

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4 Behavioural Objectives

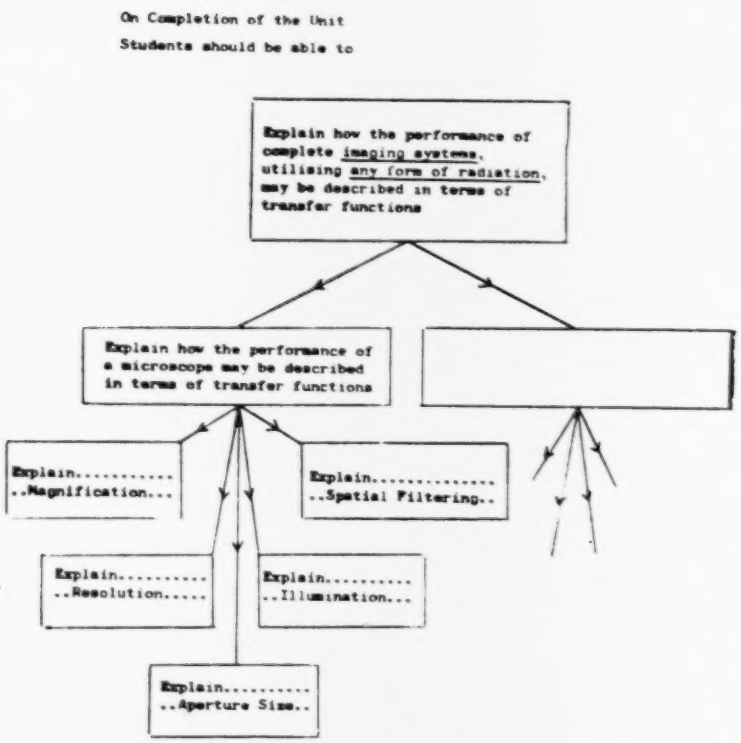
The paper on "Behavioural Objectives" [2] describes the nature of behavioural objectives and provides basic rules concerning their construction, while the paper on "Resolution of Conflicting Claims Concerning Behavioural Objectives" [3] reviews research into how student learning is affected by the provision of behavioural objectives. Here our particular interest is limited to how such objectives might be used to help develop assessment material. In the process it is inevitable that we will also see how it can be used to help structure and analyse instructional material.

The procedure recommended is one of deriving detailed objectives step by step from general statements of educational intent, recording each step in the form of a flow diagram. This does not imply that only one set of behavioural objectives can be derived from the initial statements. Nothing is further from the truth. However, what it does is to make explicit the logic used in deriving stated objectives thus opening up that logic to public inspection and discussion. Once detailed objectives have been stated the type of assessment required to measure these objectives becomes much clearer.

A flow diagram (diagram 2) used in the actual development of a physics Unit should illustrate the point. The author's ultimate aim was that students should be able to:

> Explain how the performance of complete <u>imaging systems</u> utilising <u>any form of radiation</u> may be described in terms of transfer functions.

Diagram 2. Derivation of more Specific Objectives from a General Learning Outcome.


On Completion of the Unit
Students should be able to
Explain how the performance of complete imaging systems, utilising any form of radiation, may be described in terms of transfer functions
Explain how the performance of a microscope may be described in terms of transfer functions
Explain.....
..Magnification...
Explain.....
..Spatial Filtering..
Explain.....
..Resolution.....
Explain.....
..Illumination...
Explain.....
..Aperture Size..

Working backwards from this the author believed that this might be achieved if students were able to explain the performance of a number of imaging systems, such as the microscope, in terms of transfer functions. Each sub-aim could be similarly broken down into more specific terms. Thus the author felt that if students were to be able to explain the performance of the microscope in terms of transfer functions they would need to explain the performance of the individual microscope parts in similar terms.

An author may use such logic to help him structure his instructional material while course team members may use the flow diagrams developed to review weaknesses in the structure. In addition authors may be encouraged to produce as many test items as possible for each of the most specific objectives identified. Each objective might then be stated in very specific terms by stating that it will be measured by means of a representative sample of items selected at random from those related to the specified objective. If an item bank is used for this purpose an equivalent sample of items may be made available to students and future test designers, the items related to a given objective being identified by such characteristics as indices of facility and discrimination as well as indicators of content and objective covered.

Needless to say this paper cannot be more than a brief review of a limited number of aspects of assessment. Those wishing to pursue the topic further may find it useful to look at a series of papers related to the Open University's Computer Marked Assignment System.

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